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(54) Title: POWER CABLE COMPOSITIONS FOR STRIPPABLE ADHESION

(57) Abstract: The present invention is a semiconductive power cable composition made from or containing (a) a mixture of a hightemperature polymer and a soft polymer, and (b) a conductive filler, wherein a semiconductive cable layer prepared from the composition strippably adheres to a second cable layer. The invention also includes a semiconductive cable layer prepared from the semiconductive power cable composition as well as a power cable construction prepared by applying the semiconductive cable layer over a wire or cable.



**WO 2004/088674 A1**

**AMENDED CLAIMS**

[received by the International Bureau on 19 October 2004 (19.10.04);  
original claim 1 amended, claims 2, 3 cancelled, claims 4-21 renumbered to 2-19, former  
claim 16 (now 14) amended]

**AMENDED CLAIMS**

[received by the International Bureau on 19 October 2004 (19.10.04);  
original claim 1 amended, claims 2, 3 cancelled, claims 4-21 renumbered to 2-19, former  
claim 16 (now 14) amended]

**AMENDED CLAIMS**

[received by the International Bureau on 19 October 2004 (19.10.04);  
original claim 1 amended, claims 2, 3 cancelled, claims 4-21 renumbered to 2-19, former  
claim 16 (now 14) amended]

- 1 1. A semiconductive power cable composition comprising:
  - 2 a. a mixture of a high-temperature polymer and a soft polymer; and
  - 3 b. a conductive filler,
- 4 wherein
  - 5 (i) a semiconductive cable layer prepared from the composition strippably
  - 6 adheres to a second cable layer,
  - 7 (ii) in the absence of a curing agent, the semiconductive cable layer having
  - 8 a heat resistance of less than 100% as measured by a Hot Creep test at
  - 9 a testing temperature of 150 degrees Centigrade,
  - 10 (iii) the high temperature polymer being a polymer suitable to impart heat
  - 11 resistance to the semiconductive cable layer, and
  - 12 (iv) the soft polymer being a polymer that enhances the processing
  - 13 characteristics of the high temperature polymer.
- 1 2. The semiconductive power cable composition of Claim 1 wherein the high-  
2 temperature polymer is selected from the group consisting of polypropylenes,  
3 polyesters, nylons, polysulfones, and polyaramides and the soft polymer is selected  
4 from the group consisting of polyethylenes, polypropylenes, polyesters, and rubbers.
- 1 3. The semiconductive power cable composition of Claim 2 wherein the high-  
2 temperature polymer is a polypropylene and the soft polymer is a polyethylene.
- 1 4. The semiconductive power cable composition of Claim 3 wherein the  
2 polyethylene is a copolymer of a polar monomer and a nonpolar monomer.
- 1 5. The semiconductive power cable composition of Claim 1 wherein the  
2 conductive filler is selected from the group consisting of carbon blacks, carbon fibers,  
3 carbon nanotubes, graphite particles, metals, and metal-coated particles.
- 1 6. The semiconductive power cable composition of Claim 1 wherein the second  
2 cable layer being chemically-crosslinked.
- 1 7. The semiconductive power cable composition of Claim 1, further comprising a  
2 curing agent.
- 1 8. The semiconductive power cable composition of Claim 1 further comprising a  
2 coupling agent.
- 1 9. The semiconductive power cable composition of Claim 8 wherein the coupling  
2 agent reduces the amount of a curing agent required to impart heat resistance to the  
3 semiconductive cable layer.

- 1 10. The semiconductive power cable composition of Claim 9 further comprising a  
2 curing agent.
- 1 11. The semiconductive power cable composition of Claim 1 wherein the mixture  
2 further comprises a compatibilizing polymer.
- 1 12. A semiconductive cable layer prepared from the semiconductive power cable  
2 composition of Claim 1.
- 1 13. A power cable construction prepared by applying the semiconductive cable  
2 layer of Claim 12 over a wire or cable.
- 1 14. A process for preparing a semiconductive power cable composition  
2 comprising the step of:  
3       blending a mixture of a high-temperature polymer, a soft polymer, and a  
4       conductive filler,  
5       wherein  
6       (i)     a semiconductive cable layer prepared from the composition strippably  
7             adheres to a second cable layer,  
8       (ii)    in the absence of a curing agent, the semiconductive cable layer having  
9             a heat resistance of less than 100% as measured by a Hot Creep test at  
10            a testing temperature of 150 degrees Centigrade,  
11       (iii)   the high temperature polymer being a polymer suitable to impart heat  
12             resistance to the semiconductive cable layer, and  
13       (iv)    the soft polymer being a polymer that enhances the processing  
14             characteristics of the high temperature polymer.
- 1 15. The process of Claim 14, wherein the mixture further comprises a coupling  
2 agent.
- 1 16. A process for preparing a semiconductive power cable composition  
2 comprising the steps of:  
3       a.     reactively-coupling a mixture of a high-temperature polymer, a soft  
4             polymer, and a coupling agent, in the presence of a conductive filler, wherein  
5             the coupling agent reduces the amount of a curing agent required to impart  
6             heat resistance to a semiconductive cable layer prepared from a mixture of the  
7             high-temperature polymer, the soft polymer, and the conductive filler in the  
8             absence of the coupling agent; and  
9       b.     admixing a curing agent,

10 wherein a semiconductive cable layer prepared from the composition strippably  
11 adheres to a second cable layer.

1 17. A process for preparing a power cable comprising the steps of:

2 a. extruding a semiconductive power cable composition comprising a  
3 mixture of a high-temperature polymer, a soft polymer, and a conductive filler,  
4 over a metallic conductor to yield a semiconductive cable layer over the  
5 metallic conductor; and

6 b. extruding a polymer-dielectric insulation over the semiconductive  
7 cable layer.

1 18. The process for preparing a power cable of Claim 17 further comprising the  
2 step of

3 c. extruding a second semiconductive power cable composition over the  
4 polymer-dielectric insulation to yield a second semiconductive cable layer.

1 19. A process for preparing a power cable comprising the steps of:

2 a. extruding a power cable semiconductive composition comprising a  
3 mixture of a high-temperature polymer, a soft polymer, and a conductive filler,  
4 over a metallic conductor to yield a semiconductive cable layer over the  
5 metallic conductor;

6 b. extruding a chemically-crosslinkable insulation composition over the  
7 semiconductive cable layer;

8 c. extruding a second semiconductive power cable composition over the  
9 polymer-dielectric insulation to yield a second semiconductive cable layer;  
10 and

11 d. crosslinking the chemically-crosslinkable insulation composition to  
12 yield a crosslinked, polymer-dielectric insulation.

Polyethylenes include homopolymers of ethylene and copolymers of ethylene and one or more alpha-olefins, and, optionally, a diene. The polyethylene can also be a copolymer of ethylene and an unsaturated ester such as a vinyl ester (e.g., vinyl acetate or an acrylic or methacrylic acid ester), a copolymer of ethylene and an  
5 unsaturated acid such as acrylic or methacrylic acid, or a copolymer of ethylene and a vinyl silane (e.g., vinyltrimethoxysilane and vinyltriethoxysilane) as well as interpolymers of any of these comonomers. Post-modified polyethylenes of any other of the above are considered within the scope of this invention as well as blends thereof. Preferred polyethylenes are homopolymers of ethylene, copolymers of  
10 ethylene and one or more alpha-olefins, and a copolymer of ethylene and an unsaturated ester. More preferred polyethylenes for soft polymers are copolymers of a polar monomer and a nonpolar comonomer. Most preferred polyethylenes are copolymers of ethylene and an unsaturated ester.

Suitable polypropylenes include homopolymers of propylene, copolymers of  
15 propylene and other olefins, and terpolymers of propylene, ethylene, and dienes.

Suitable polyesters include thermoplastic resins comprising a saturated dicarboxylic acid and a saturated difunctional alcohol. Specific examples include polyethylene terephthalate, polypropylene terephthalate (or trimethylene terephthalate), polybutylene terephthalate, polytetramethylene terephthalate,  
20 polyhexamethylene terephthalate, polycyclohexane-1,4-dimethylol terephthalate, and polyneopentyl terephthalate. Preferred polyesters are polyethylene terephthalate, polypropylene terephthalate (or trimethylene terephthalate), and polybutylene terephthalate.

Suitable nylons include nylon 6, nylon 6,6, and nylons based upon longer  
25 chain-length diamines. Preferred nylons are nylon 6 and nylon 6,6.

Suitable rubbers include thermoplastic rubbers, ethylene propylene diene rubber, styrene-butadiene block copolymers, styrene-butadiene rubber, polybutadiene rubbers, isoprene rubbers, nitrile rubbers, polychloroprene rubbers, hydrogenated styrene-butadiene block copolymers, methacrylate butadiene styrene rubber, acrylic  
5 elastomers (such ethylene methylacrylate), fluoroelastomers, and thermoplastic elastomers (such as thermoplastic urethanes, polyamids, and polyester ethers).

Suitable conductive fillers include carbon blacks, carbon fibers, carbon nanotubes, graphite particles, metals, and metal-coated particles. Preferred  
conductive fillers are carbon blacks. Preferably, the conductive filler will be present  
10 in the composition in an amount sufficient to impart a volume resistivity of less than 50,000 ohm-cm for a semiconductive cable layer prepared therefrom, as measured by the methods described in ICEA S-66-524.

In addition, a curing agent may be present in the semiconductive composition. Suitable curing agents include organic peroxides, azides, organofunctional silanes,  
15 maleated polyolefins, phenols, and sulfur vulcanizing agents. Suitable organic peroxides include aromatic diacyl peroxides, aliphatic diacyl peroxides, dibasic acid peroxides, ketone peroxides, alkyl peroxyesters, and alkyl hydroperoxides. Suitable azide curing agents include alkyl azide, aryl azides, acyl azides, azidoformates, phosphoryl azides, phosphinic azides, silyl azides, and polyfunctional azides.  
20 Suitable silanes include unsaturated silanes that comprise an ethylenically unsaturated hydrocarbyl group, such as a vinyl, allyl, isopropenyl, butenyl, cyclohexenyl or  $\gamma$ -(meth)acryloxy allyl group, and a hydrolyzable group, such as, for example, a hydrocarbyloxy, hydrocarbonyloxy, or hydrocarbylamino group. Preferred curing agents are organic peroxides.

In addition, the semiconductive power cable composition may further comprise a coupling agent. The term "coupling agent," as used herein, means a compound or mixture of compounds used for the purposes of coupling or grafting a polymer or polymer blend. The coupling agent may be present in an amount  
5 sufficient to reduce the amount of a curing agent required to impart heat resistance to the semiconductive cable layer. The coupling agent may be the same compound as the curing agent..

Suitable coupling agents include organic peroxides, azides, organofunctional silanes, maleated polyolefins, phenols, and sulfur vulcanizing agents. Suitable  
10 organic peroxides include aromatic diacyl peroxides, aliphatic diacyl peroxides, dibasic acid peroxides, ketone peroxides, alkyl peroxyesters, and alkyl hydroperoxides. Suitable azide coupling agents include alkyl azide, aryl azides, acyl azides, azidoformates, phosphoryl azides, phosphinic azides, silyl azides, and polyfunctional azides. Suitable silanes include unsaturated silanes that comprise an  
15 ethylenically unsaturated hydrocarbyl group, such as a vinyl, allyl, isopropenyl, butenyl, cyclohexenyl or  $\gamma$ -(meth)acryloxy allyl group, and a hydrolyzable group, such as, for example, a hydrocarbyloxy, hydrocarbonyloxy, or hydrocarbylamino group. Preferred coupling agents are organic peroxides.

In addition, the semiconductive power cable composition may further  
20 comprise a compatibilizing polymer. As used herein, the term "compatibilizing polymers" includes those polymers having an affinity for both the high-temperature polymer and the soft polymer. Preferred compatibilizing polymer are copolymers (such as ethylene-alpha-olefin copolymers) and functionalized polymers (such as maleated polyolefins and glycidil-functional polyolefins). Based on the selection of



the high-temperature and soft polymers, a person skilled in the art can readily identify other suitable compatibilizing polymers.

In addition, the composition may contain other additives such as antioxidants, stabilizers, blowing agents, pigments, processing aids, and cure boosters.

5 In a preferred embodiment, the present invention is a semiconductive power cable composition comprising (a) a mixture of a high-temperature polymer and a soft polymer and (b) a conductive filler, wherein a semiconductive cable layer prepared from the composition strippably adheres to a second cable layer. The high-temperature polymer and the soft polymer may have different heat resistance. In a  
10 more preferred embodiment, the semiconductive cable layer has a heat resistance of less than 100% as measured by a Hot Creep test at a testing temperature of 150 degrees Centigrade. Also, in a more preferred embodiment, the second cable layer is a chemically-crosslinked layer.

In an alternate embodiment, a semiconductive cable layer is prepared from the  
15 semiconductive power cable composition. In a yet another embodiment, a power cable construction is prepared by applying the semiconductive cable layer over a wire or cable.

In another alternate embodiment, the present invention is a process for preparing a semiconductive power cable composition comprising the step of blending  
20 a mixture of a high-temperature polymer, a soft polymer, and a conductive filler, wherein a semiconductive cable layer prepared from the composition strippably adheres to a second cable layer. In this embodiment, the mixture may further comprise a coupling agent. Preferably, the coupling agent reduces the amount of a curing agent required to impart heat resistance to a semiconductive cable layer

prepared from a mixture of the high-temperature polymer, the soft polymer, and the conductive filler in the absence of the coupling agent.

In yet another embodiment, the invention is a process for preparing a semiconductive power cable composition comprising the steps of (a) reactively-  
5 coupling a mixture of a high-temperature polymer, a soft polymer, and a coupling agent, in the presence of a conductive filler, and (b) admixing a curing agent, wherein a semiconductive cable layer prepared from the composition strippably adheres to a second cable layer. Preferably, the coupling agent reduces the amount of the curing agent required to impart heat resistance to a semiconductive cable layer prepared from  
10 a mixture of the high-temperature polymer, the soft polymer, and the conductive filler in the absence of the coupling agent.

In another embodiment of the present invention, the invention is a process for preparing a power cable comprising the steps of (a) extruding a semiconductive power cable composition comprising a mixture of a high-temperature polymer, a soft  
15 polymer, and a conductive filler, over a metallic conductor to yield a semiconductive cable layer over the metallic conductor, and (b) extruding a polymer-dielectric insulation over the semiconductive cable layer. This embodiment may further comprise the step of (c) extruding a second semiconductive power cable composition over the polymer-dielectric insulation to yield a second semiconductive cable layer.

20 In an alternate aspect of this embodiment, the invention is a process comprising the steps of (a) extruding a power cable semiconductive composition comprising a mixture of a high-temperature polymer, a soft polymer, and a conductive filler, over a metallic conductor to yield a semiconductive cable layer over the metallic conductor, (b) extruding a chemically-crosslinkable insulation composition  
25 over the semiconductive cable layer, (c) extruding a second semiconductive power

cable composition over the polymer-dielectric insulation to yield a second semiconductive cable layer, and (d) crosslinking the chemically-crosslinkable insulation composition to yield a crosslinked, polymer-dielectric insulation.

### EXAMPLES

5           The following non-limiting examples illustrate the invention.

#### Examples 1-7

          In Comparative Examples 1, 6, and 7 and Examples 2, 4, and 5, the mixtures were combined in a lab-scale compounder to achieve a melt temperature of 190 degrees Centigrade for 5 minutes. In Example 3, the mixture of the high-temperature  
10   polymer, the soft polymer, and the conductive filler were combined in a lab-scale compounder to achieve a melt temperature of 190 degrees Centigrade for 5 minutes and then allowed to cool; then the peroxide was added at 120 degrees Centigrade.

          Each exemplified formulation was evaluated for Hot Creep performance and adhesion to a polyethylene-insulation substrate. The Hot Creep test specimens were  
15   evaluated for their resistance to thermal deformation under load conditions of 20 N/sq. cm. tensile stress for 15 minutes at 150 degrees Centigrade. Elongation and residual deformation were measured. Residual deformation is reported in Table I as % Hot Set.

          For the adhesion measurement, 30 mil plaques of the exemplified formulations  
20   were prepared. A polyethylene-insulation substrate was prepared from The Dow Chemical Company's commercially available HFDB-4202 crosslinkable polyethylene insulation at 120 degrees Centigrade. Subsequently, the test plaques and the polyethylene-insulation substrate were molded together under pressure at a temperature in excess of 180 degrees Centigrade for a length time sufficient for the  
25   substrate to cure. Next, the dual-layer specimens were conditioned at ambient

temperature overnight. A one-half inch wide strip was scored from the dual-layer specimen. A 90-degree peel test was performed in an INSTRON™ tensile machine at a peel rate of 20inches per minute.

The polymeric materials for the exemplified formulations were added in the concentrations shown in Table I and include:

- (1) duPont Elvax 265™ ethylene vinylacetate copolymer (EVA-1), having a vinylacetate content of 28% by weight and a melt index of 3 g/10minutes;
- (2) DXM-451™ ethylene vinylacetate copolymer (EVA-2), having a vinylacetate content of 18% by weight and a melt index of 3 g/10minutes and commercially available from The Dow Chemical Company;
- (3) 5D45™ polypropylene (PP-1), which was a fractional homopolymer having a melt flow rate of 0.8 and commercially available from The Dow Chemical Company; and
- (4) a homopolymer of polypropylene (PP-2) having a melt flow rate of 20.

The carbon black was CSX614 and commercially available from Cabot Corporation. Each formulation contained 55 parts per hundred polymer (pphr) of carbon black. The peroxide used was TRIGANOX 101, and commercially available from Akzo Nobel. For Comparative Example 1 and Examples 2-5, the peroxide was added in the amount of 0.4 pphr during the compounding. For Comparative Example 6, the peroxide was added in the amount of 0.4 pphr following the compounding. The formulation for Comparative Example 7 did not contain any peroxide.

While the peroxide in the formulation exemplified as Comparative Example 1 was fully reacted during compounding, the test specimens were unable to withstand

the Hot Creep load. Without any residual unreacted peroxide, the test specimen for Comparative Example 1 was fully bonded to the polyethylene-insulation substrate. This bonding also demonstrates that, if the formulation had not contained any peroxide during the compounding, the resulting test specimen would have fully bond  
5 itself to the polyethylene-insulation substrate and that current practices using EVA-2 would result in a fully-bonded test specimen.

Table I shows that formulation exemplified as Example 2 had desirable Hot Creep and strippability from the polyethylene-insulation substrate. While the Example 3 formulation showed improved heat resistance, its test specimens became  
10 fully bonded to the polyethylene-insulation substrate. Examples 4 and 5 demonstrated formulations with improvements over the Example 2 formulation in heat resistance and strippability.

While Comparative Example 6 demonstrated excellent heat resistance, its unreacted peroxide (i.e., peroxide not consumed during compounding) did not  
15 sufficiently reduce the curative level of the mixture to prevent the test specimens from fully bonding to the polyethylene-insulation substrate. Comparative Example 7, which is a blend with no coupling agent, yielded test specimens with relatively poor heat resistance.

TABLE I

Component	Comp. Ex. 1	Ex. 2	Ex. 3	Ex. 4	Ex. 5	Comp. Ex. 6	Comp. Ex. 7
EVA-1				65	65		
EVA-2	100	65	65			65	65
PP-1		35		35		35	35
PP-2			35		35		
Test							
Adhesion	Bonded	2.5 (strippable)	Bonded	1.1 (strippable)	3.8 (strippable)	Bonded	Bonded
Hot Creep %	Failed	27	18	18	18	0	56
Hot Set %	---	6.3	5.5	1.6	0.8	0.1	22

### Example 8

In Example 8, a mixture was combined in a lab-scale compounder to achieve a melt temperature of 190 degrees Centigrade for 5 minutes. The mixture contained 65 parts of EVA-1, 35 parts of PP-1, 55 parts per hundred polymer (pphr) of Cabot Corporation CSX614 carbon black, and 0.4 pphr Akzo Nobel TRIGANOX 101 peroxide.

As part of a 15-kilovolt power cable design, the mixture was extruded as a semiconductive layer over a peroxide crosslinkable polyethylene insulation (HFDB-4202). The HFDB-4202 crosslinkable polyethylene insulation is available commercially from The Dow Chemical Company.

The 15-kilovolt power cable design used a 1/0 AWG aluminum conductor, 15 mils of a crosslinkable semiconductive power cable compound, 175 mils of the crosslinkable polyethylene insulation, and 40 mils of the semiconductive power cable composition of Example 8. The extruded cable was passed through a hot, dry nitrogen tube (continuous vulcanization tube) wherein the thermal decomposition of organic peroxide initiates polymer crosslinking. The cured cable was then passed through a cooling water trough.

The outer semiconductive power cable composition of Example 8 was found to strippably adhere to the crosslinked polyethylene cable insulation, having a strip tension of 11-12 pounds per 0.5 inches. It also had a Hot Creep elongation of 19% when tested at 150 degrees Centigrade and 0.2 MPa of applied tensile stress.

**What is claimed is:**

- 1 1. A semiconductive power cable composition comprising:
  - 2 a. a mixture of a high-temperature polymer and a soft polymer; and
  - 3 b. a conductive filler,
- 4 wherein a semiconductive cable layer prepared from the composition strippably
- 5 adheres to a second cable layer.
- 1 2. The semiconductive power cable composition of Claim 1, wherein the
- 2 semiconductive cable layer having a heat resistance of less than 100% as measured by
- 3 a Hot Creep test at a testing temperature of 150 degrees Centigrade.
- 4 3. The semiconductive power cable composition of Claim 1 wherein the high-
- 5 temperature polymer and the soft polymer have different heat resistance.
- 1 4. The semiconductive power cable composition of Claim 1 wherein the high-
- 2 temperature polymer is selected from the group consisting of polypropylenes,
- 3 polyesters, nylons, polysulfones, and polyaramides and the soft polymer is selected
- 4 from the group consisting of polyethylenes, polypropylenes, polyesters, and rubbers.
- 1 5. The semiconductive power cable composition of Claim 4 wherein the high-
- 2 temperature polymer is a polypropylene and the soft polymer is a polyethylene.
- 1 6. The semiconductive power cable composition of Claim 5 wherein the
- 2 polyethylene is a copolymer of a polar monomer and a nonpolar monomer.
- 1 7. The semiconductive power cable composition of Claim 1 wherein the
- 2 conductive filler is selected from the group consisting of carbon blacks, carbon fibers,
- 3 carbon nanotubes, graphite particles, metals, and metal-coated particles.
- 1 8. The semiconductive power cable composition of Claim 1 wherein the second
- 2 cable layer being chemically-crosslinked.
- 1 9. The semiconductive power cable composition of Claim 1, further comprising a
- 2 curing agent.
- 1 10. The semiconductive power cable composition of Claim 1 further comprising a
- 2 coupling agent.
- 1 11. The semiconductive power cable composition of Claim 10 wherein the
- 2 coupling agent reduces the amount of a curing agent required to impart heat resistance
- 3 to the semiconductive cable layer.
- 1 12. The semiconductive power cable composition of Claim 11 further comprising
- 2 a curing agent.



1 13. The semiconductive power cable composition of Claim 1 wherein the mixture  
2 further comprises a compatibilizing polymer.

1 14. A semiconductive cable layer prepared from the semiconductive power cable  
2 composition of Claim 1.

1 15. A power cable construction prepared by applying the semiconductive cable  
2 layer of Claim 14 over a wire or cable.

1 16. A process for preparing a semiconductive power cable composition  
2 comprising the step of:

3 blending a mixture of a high-temperature polymer, a soft polymer, and a  
4 conductive filler,

5 wherein a semiconductive cable layer prepared from the composition strippably  
6 adheres to a second cable layer.

1 17. The process of Claim 16, wherein the mixture further comprises a coupling  
2 agent.

1 18. A process for preparing a semiconductive power cable composition  
2 comprising the steps of:

3 a. reactively-coupling a mixture of a high-temperature polymer, a soft  
4 polymer, and a coupling agent, in the presence of a conductive filler, wherein  
5 the coupling agent reduces the amount of a curing agent required to impart  
6 heat resistance to a semiconductive cable layer prepared from a mixture of the  
7 high-temperature polymer, the soft polymer, and the conductive filler in the  
8 absence of the coupling agent; and

9 b. admixing a curing agent,

10 wherein a semiconductive cable layer prepared from the composition strippably  
11 adheres to a second cable layer.

1 19. A process for preparing a power cable comprising the steps of:

2 a. extruding a semiconductive power cable composition comprising a  
3 mixture of a high-temperature polymer, a soft polymer, and a conductive filler,  
4 over a metallic conductor to yield a semiconductive cable layer over the  
5 metallic conductor; and

6 b. extruding a polymer-dielectric insulation over the semiconductive  
7 cable layer.

- 1 20. The process for preparing a power cable of Claim 19 further comprising the  
2 step of
- 3 c. extruding a second semiconductive power cable composition over the  
4 polymer-dielectric insulation to yield a second semiconductive cable layer.
- 1 21. A process for preparing a power cable comprising the steps of:
- 2 a. extruding a power cable semiconductive composition comprising a  
3 mixture of a high-temperature polymer, a soft polymer, and a conductive filler,  
4 over a metallic conductor to yield a semiconductive cable layer over the  
5 metallic conductor;
- 6 b. extruding a chemically-crosslinkable insulation composition over the  
7 semiconductive cable layer;
- 8 c. extruding a second semiconductive power cable composition over the  
9 polymer-dielectric insulation to yield a second semiconductive cable layer;  
10 and
- 11 d. crosslinking the chemically-crosslinkable insulation composition to  
12 yield a crosslinked, polymer-dielectric insulation.

# INTERNATIONAL SEARCH REPORT

International Application No

PCT/US2004/009075

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 7	H01B1/20	H01B1/22	H01B1/24	C08L23/08	C08L23/10
	C08L67/00	C08L69/00	C08K3/04	C08K3/00	C08K3/10
	C08K7/06				

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H01B C08L C08K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ, WPI Data

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6 455 771 B1 (LEE WEI-KUO ET AL) 24 September 2002 (2002-09-24) claims; examples	4-15, 17-21
X	PATENT ABSTRACTS OF JAPAN vol. 2002, no. 10, 10 October 2002 (2002-10-10) & JP 2002 179854 A (DU PONT MITSUI POLYCHEM CO LTD), 26 June 2002 (2002-06-26) abstract	4-15, 17-21
X	US 6 274 066 B1 (EASTER MARK R) 14 August 2001 (2001-08-14) claims; examples	4-15, 17-21
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☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

\* Special categories of cited documents:

- \*A\* document defining the general state of the art which is not considered to be of particular relevance
- \*E\* earlier document but published on or after the international filing date
- \*L\* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- \*O\* document referring to an oral disclosure, use, exhibition or other means
- \*P\* document published prior to the international filing date but later than the priority date claimed

- \*T\* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- \*X\* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- \*Y\* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- \* & \* document member of the same patent family

Date of the actual completion of the international search

9 August 2004

Date of mailing of the international search report

19/08/2004

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Authorized officer

Zeslawski, W

## INTERNATIONAL SEARCH REPORT

International Application No

PCT/US2004/009075

## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6 232 376 B1 (ISHIHARA KOJI ET AL) 15 May 2001 (2001-05-15) claim 6; examples -----	4-15, 17-21
X	EP 1 052 654 A (UNION CARBIDE CHEM PLASTIC) 15 November 2000 (2000-11-15) claims; tables -----	4-15, 17-21
X	PATENT ABSTRACTS OF JAPAN vol. 2000, no. 23, 10 February 2001 (2001-02-10) & JP 2001 167634 A (NIPPON UNICAR CO LTD), 22 June 2001 (2001-06-22) abstract -----	4-15, 17-21
X	US 2002/032258 A1 (ISHIHARA KOJI ET AL) 14 March 2002 (2002-03-14) claims; examples -----	4-15, 17-21
X	EP 0 858 081 A (MITSUBISHI CHEM CORP) 12 August 1998 (1998-08-12) claims; examples -----	4-15, 17-21
X	EP 0 334 993 A (HITACHI CABLE) 4 October 1989 (1989-10-04) claims; examples -----	4-15, 17-21

**FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210**

## Continuation of Box II.2

Present claims 1-3, 16 relate to an extremely large number of possible compositions/processes. In fact, the claims contain so many options, variables, possible permutations and provisos that a lack of clarity (and conciseness) within the meaning of Article 6 PCT arises to such an extent as to render a meaningful search of the claims impossible. Consequently, the search has been carried out for those parts of the application which do appear to be clear (and concise).

The applicant's attention is drawn to the fact that claims relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure. If the application proceeds into the regional phase before the EPO, the applicant is reminded that a search may be carried out during examination before the EPO (see EPO Guideline C-VI, 8.5), should the problems which led to the Article 17(2) declaration be overcome.

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US2004/009075

### Box II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☒ Claims Nos.:  
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:  
see FURTHER INFORMATION sheet PCT/ISA/210
3. ☐ Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

### Box III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

#### Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/US2004/009075

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**PUB-NO:** WO2004088674A1  
**DOCUMENT-IDENTIFIER:** WO 2004088674 A1  
**TITLE:** POWER CABLE COMPOSITIONS FOR  
STRIPPABLE ADHESION  
**PUBN-DATE:** October 14, 2004

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**APPL-NO:** US2004009075

**APPL-DATE:** March 25, 2004

**PRIORITY-DATA:** US45794303P (March 27, 2003)



**INT-CL (IPC) :** H01B001/20 , H01B001/22 ,  
H01B001/24 , C08L023/08 ,  
C08L023/10 , C08L067/00 ,  
C08L069/00 , C08K003/04 ,  
C08K003/00 , C08K003/10 ,  
C08K007/06

**EUR-CL (EPC) :** C08L023/08 , C08L067/00

**ABSTRACT:**

CHG DATE=20041227 STATUS=O>The present invention is a semiconductive power cable composition made from or containing (a) a mixture of a high-temperature polymer and a soft polymer, and (b) a conductive filler, wherein a semiconductive cable layer prepared from the composition strippably adheres to a second cable layer. The invention also includes a semiconductive cable layer prepared from the semiconductive power cable composition as well as a power cable construction prepared by applying the semiconductive cable layer over a wire or cable.